

Claims:

1. A method of shaping input packet traffic, said method comprising steps
of:

5 determining a constraint parameter dependent upon a probability density
function; and

constraining, based upon said parameter, transmission of the input packet traffic,
thereby to produce output packet traffic having a pre-determined entropy bound.

10 2. A method according to claim 1, wherein prior to the determining step,
the method comprises a further step of:

selecting a type of the probability density function.

15 3. A method according to claim 2, wherein a probability distribution
function which is derived from the probability density function of the selected type is
evaluated in conjunction with the determining step, thereby permitting said determining
of the constraint parameter.

20 4. A method according to claim 2, wherein a probability distribution
function which is derived from the probability density function of the selected type is
evaluated prior to the determining step, thereby permitting said determining of the
constraint parameter.

5. A method according to claim 4, wherein the evaluated probability distribution function is arranged as a look-up table of constraint parameter values, and wherein the determining step comprises sub-steps of:

- 5 selecting, from the look-up table, a smallest one of said constraint parameter values which matches a characteristic of the input packet traffic; and
deleting said smallest constraint parameter value from the look-up table.

6. A method according to claim 5, wherein the look-up table is refreshed to an original state after a time period.

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7. A method according to claim 1, wherein the probability density function is an exponential function.

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8. A packet traffic shaper comprising:
determination means configured to determine a constraint parameter dependent upon a probability density function; and
constraining means configured to constrain, based upon the parameter, transmission of traffic input to said constraining means, thereby to produce output traffic having a pre-determined entropy bound.

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9. A packet traffic shaper according to claim 8, further comprising:
selection means configured to select a type of the probability density function.

10. A packet traffic shaper according to claim 9, further comprising:

derivation means configured to derive a probability distribution function from the probability density function of the selected type, said derivation being performed in conjunction with determining the constraint parameter.

5 11. A packet traffic shaper according to claim 9, further comprising:
derivation means configured to derive a probability distribution function from the probability density function of the selected type, said derivation being performed prior to determining the constraint parameter.

10 12. A packet traffic shaper according to claim 11, wherein the derived probability distribution function is arranged as a look-up table of constraint parameter values, and wherein the determination means comprise:
selecting means configured to select, from the look-up table, a smallest one of said constraint parameter values which matches a characteristic of the input packet traffic;
15 and
deleting means configured to delete said smallest constraint parameter value from the look-up table.

13. A packet traffic shaper according to claim 12, further comprising:
20 refresh means configured to refresh the look-up table to an original state after a time period.

14. A packet traffic shaper according to claim 8, wherein the probability density function is an exponential function.

15. A computer readable memory medium for storing a program for an apparatus which shapes input packet traffic, said program comprising:

code for a determining step for determining a constraint parameter dependent upon a probability density function; and

5 code for a constraining step for constraining, based upon said parameter, transmission of the input packet traffic, thereby to produce output packet traffic having a pre-determined entropy bound.

16. A computer readable memory medium according to claim 15, further
10 comprising code for a selecting step for selecting a type of the probability density function.

17. A computer readable memory medium according to claim 16, further comprising:

15 code for a deriving step for deriving a probability distribution function from the probability density function of the selected type, said derivation being performed in conjunction determining the constraint parameter.

18. A computer readable memory medium according to claim 16, further
20 comprising:

code for a deriving step for deriving a probability distribution function from the probability density function of the selected type, said derivation being performed prior to determining the constraint parameter.

19. A computer readable memory medium according to claim 18, wherein
the derived probability distribution function is arranged as a look-up table of constraint
parameter values, and wherein the code for the determining step comprises:

code for a selecting step for selecting, from the look-up table, a smallest one of

5 said constraint parameter values which matches a characteristic of the input packet traffic;
and

code for a deleting step for deleting said smallest constraint parameter value
from the look-up table.

10 20. A computer readable memory medium according to claim 19, further
comprising:

code for a refresh step for refreshing the look-up table to an original state after a
time period.

15 21. A computer readable memory medium according to claim 15, wherein
the probability density function is an exponential function.

22. A computer program for an apparatus which shapes input packet traffic,
said program comprising:

20 code for a determining step for determining a constraint parameter dependent
upon a probability density function; and

code for a constraining step for constraining, based upon said parameter,
transmission of the input packet traffic, thereby to produce output packet traffic having a
pre-determined entropy bound.

23. A computer program according to claim 22, further comprising code for a selecting step for selecting a type of the probability density function.

24. A computer program according to claim 23, further comprising:
5 code for a deriving step for deriving a probability distribution function from the probability density function of the selected type, said derivation being performed in conjunction determining the constraint parameter.

25. A computer program according to claim 23, further comprising:
10 code for a deriving step for deriving a probability distribution function from the probability density function of the selected type, said derivation being performed prior to determining the constraint parameter.

26. A computer program according to claim 25, wherein the derived
15 probability distribution function is arranged as a look-up table of constraint parameter values, and wherein the code for the determining step comprises:

code for a selecting step for selecting, from the look-up table, a smallest one of said constraint parameter values which matches a characteristic of the input packet traffic;
and

20 code for a deleting step for deleting said smallest constraint parameter value from the look-up table.

27. A computer program according to claim 26, further comprising:
code for a refresh step for refreshing the look-up table to an original state after a
25 time period.

28. A computer program according to claim 22, wherein the probability density function is an exponential function.

5 29. A method of policing input packet traffic, said method comprising steps of:

determining a constraint parameter dependent upon a probability density function; and

10 tagging, based upon said parameter, conforming packets in the input packet traffic, thereby to produce output packet traffic wherein tagged packets comprise a policed traffic stream having a pre-determined entropy bound.

30. A method according to claim 29, wherein prior to the determining step,

15 the method comprises a further step of:

selecting a type of the probability density function.

31. A method according to claim 30, wherein a probability distribution function which is derived from the probability density function of the selected type is evaluated in conjunction with the determining step, thereby permitting said determining of the constraint parameter.

32. A method according to claim 30, wherein a probability distribution function which is derived from the probability density function of the selected type is

evaluated prior to the determining step, thereby permitting said determining of the constraint parameter.

33. A method according to claim 32, wherein the evaluated probability distribution function is arranged as a look-up table of constraint parameter values, and wherein the determining step comprises sub-steps of:

selecting, from the look-up table, a smallest one of said constraint parameter values which matches a characteristic of the input packet traffic; and
deleting said smallest constraint parameter value from the look-up table.

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34. A method according to claim 33, wherein the look-up table is refreshed to an original state after a time period.

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35. A method according to claim 29, wherein the probability density function is an exponential function.

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36. A packet traffic policer comprising:
determination means configured to determine a constraint parameter dependent upon a probability density function; and
tagging means configured to tag, based upon the parameter, conforming packets in traffic input to said tagging means, thereby to produce output traffic wherein tagged packets comprise a policed traffic stream having a pre-determined entropy bound.

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37. A packet traffic policer according to claim 36, further comprising:
selection means for selecting a type of the probability density function.

38. A packet traffic policer according to claim 37, further comprising:
derivation means configured to derive a probability distribution function from
the probability density function of the selected type, said derivation being performed in
5 conjunction with said determining of the constraint parameter.

39. A packet traffic policer according to claim 37, further comprising:
derivation means configured to derive a probability distribution function from
the probability density function of the selected type, said derivation being performed prior
10 to said determining of the constraint parameter.

40. A packet traffic policer according to claim 39, wherein the evaluated
probability distribution function is arranged as a look-up table of constraint parameter
values, and wherein the determining means comprise:

15 selecting means configured to select, from the look-up table, a smallest one of
said constraint parameter values which matches a characteristic of the input packet traffic;
and

deleting means configured to delete said smallest constraint parameter value
from the look-up table.

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41. A packet traffic policer according to claim 40, further comprising:
refresh means configured to refresh the look-up table to an original state after a
time period.

42. A packet traffic policer according to claim 36, wherein the probability density function is an exponential function.

43. A computer readable memory medium for storing a program for an apparatus which polices input packet traffic, said program comprising:

code for a determining step for determining a constraint parameter dependent upon a probability density function; and

code for a tagging step for tagging, based upon said parameter, conforming packets in the input packet traffic, thereby to produce output packet traffic wherein tagged

10 packets comprise a policed traffic stream having a pre-determined entropy bound.

44. A computer readable memory medium according to claim 43, further comprising code for a selecting step for selecting a type of the probability density function.

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45. A computer readable memory medium according to claim 44, further comprising:

code for a deriving step for deriving a probability distribution function from the probability density function of the selected type, said derivation being performed in conjunction with said determining of the constraint parameter.

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46. A computer readable memory medium according to claim 44, further comprising:

code for a deriving step for deriving a probability distribution function from the probability density function of the selected type, said derivation being performed prior to said determining of the constraint parameter.

5 47. A computer readable memory medium according to claim 46, wherein the evaluated probability distribution function is arranged as a look-up table of constraint parameter values, and wherein the code for the determining step comprises:

code for a selecting step for selecting, from the look-up table, a smallest one of said constraint parameter values which matches a characteristic of the input packet traffic;

10 and

code for a deleting step for deleting said smallest constraint parameter value from the look-up table.

15 48. A computer readable memory medium according to claim 47, further comprising:

code for a refresh step for refreshing the look-up table to an original state after a time period.

20 49. A computer readable memory medium according to claim 43, wherein the probability density function is an exponential function.

50. A computer program for an apparatus which polices input packet traffic, said program comprising:

code for a determining step for determining a constraint parameter dependent upon a probability density function; and

code for a tagging step for tagging, based upon said parameter, conforming packets in the input packet traffic, thereby to produce output packet traffic wherein tagged packets comprise a policed traffic stream having a pre-determined entropy bound.

5 51. A computer program according to claim 50, further comprising code for a selecting step for selecting a type of the probability density function.

52. A computer program according to claim 51, further comprising:
code for a deriving step for deriving a probability distribution function from the
10 probability density function of the selected type, said derivation being performed in
conjunction with said determining of the constraint parameter.

53. A computer program according to claim 51, further comprising:
code for a deriving step for deriving a probability distribution function from the
15 probability density function of the selected type, said derivation being performed prior to
said determining of the constraint parameter.

54. A computer program according to claim 53, wherein the evaluated probability distribution function is arranged as a look-up table of constraint parameter
20 values, and wherin the code for the determining step comprises:

code for a selecting step for selecting, from the look-up table, a smallest one of
said constraint parameter values which matches a characteristic of the input packet traffic;
and

25 code for a deleting step for deleting said smallest constraint parameter value
from the look-up table.

55. A computer program according to claim 54, further comprising:
code for a refresh step for refreshing the look-up table to an original state after a
time period.

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56. A computer program according to claim 50, wherein the probability
density function is an exponential function.

57. A method of controlling admission of a proposed additional input
10 packet traffic stream to a network node, said node having a prior input packet traffic
stream, and an output packet traffic stream carried on a link having an associated
maximum bandwidth, said method comprising steps of:

shaping the prior input packet traffic stream to have a corresponding pre-
determined entropy bound if said prior stream does not have said corresponding pre-
15 determined entropy bound;

shaping the proposed additional input packet traffic stream to have a
corresponding pre-determined entropy bound if said proposed stream does not have said
corresponding pre-determined entropy bound;

determining corresponding equivalent bandwidths for the prior traffic stream and
20 the proposed additional traffic stream; and

admitting the proposed additional traffic stream if a sum of the corresponding
equivalent bandwidths of the prior traffic stream and the proposed additional traffic
stream does not exceed said maximum bandwidth.

58. A connection admission controller configured to control admission of a proposed additional input packet traffic stream to a network node, said node having a prior input packet traffic stream, and an output packet traffic stream carried on a link having an associated maximum bandwidth, said controller comprising:

5 first shaping means configured to shape the prior input packet traffic stream to have a corresponding pre-determined entropy bound if said prior stream does not have said corresponding pre-determined entropy bound;

10 second shaping means configured to shape the proposed additional input packet traffic stream to have a corresponding pre-determined entropy bound if said proposed stream does not have said corresponding pre-determined entropy bound;

15 determining means configured to determine corresponding equivalent bandwidths for the prior traffic stream and the proposed additional traffic stream; and

admission means configured to admit the proposed additional traffic stream if a sum of the corresponding equivalent bandwidths of the prior traffic stream and the proposed additional traffic stream does not exceed said maximum bandwidth.

59. A computer readable memory medium for storing a program for an apparatus which controls admission of a proposed additional input packet traffic stream to a network node, said node having a prior input packet traffic stream, and an output packet traffic stream carried on a link having an associated maximum bandwidth, said program comprising:

code for a first shaping step for shaping the prior input packet traffic stream to have a corresponding pre-determined entropy bound if said prior stream does not have said corresponding pre-determined entropy bound;

code for a second shaping step for shaping the proposed additional input packet traffic stream to have a corresponding pre-determined entropy bound if said proposed stream does not have said corresponding pre-determined entropy bound;

code for a determining step for determining corresponding equivalent
5 bandwidths for the prior traffic stream and the proposed additional traffic stream; and

code for an admitting step for admitting the proposed additional traffic stream if a sum of the corresponding equivalent bandwidths of the prior traffic stream and the proposed additional traffic stream does not exceed said maximum bandwidth.

10 60. A computer program for an apparatus which controls admission of a proposed additional input packet traffic stream to a network node, said node having a prior input packet traffic stream, and an output packet traffic stream carried on a link having an associated maximum bandwidth, said program comprising:

code for a first shaping step for shaping the prior input packet traffic stream to
15 have a corresponding pre-determined entropy bound if said prior stream does not have said corresponding pre-determined entropy bound;

code for a second shaping step for shaping the proposed additional input packet traffic stream to have a corresponding pre-determined entropy bound if said proposed stream does not have said corresponding pre-determined entropy bound;

20 code for a determining step for determining corresponding equivalent bandwidths for the prior traffic stream and the proposed additional traffic stream; and

code for an admitting step for admitting the proposed additional traffic stream if a sum of the corresponding equivalent bandwidths of the prior traffic stream and the proposed additional traffic stream does not exceed said maximum bandwidth.

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61. A method of adjusting a present bandwidth allocated to a packet traffic stream to thereby achieve a desired quality of service, said method comprising steps of:

determining a target equivalent bandwidth required by said traffic stream to meet said desired quality of service;

5 determining a differential bandwidth dependent upon the present bandwidth and the target equivalent bandwidth;

determining, based upon said differential bandwidth, a probability distribution function; and

10 constraining, based upon said probability distribution function, transmission of the packet traffic stream, thereby (i) producing an output packet traffic having a pre-determined entropy bound, (ii) allocating to the input traffic stream said target equivalent bandwidth and (iii) achieving said desired quality of service.

62. An apparatus configured to adjust a present bandwidth allocated to a 15 packet traffic stream to thereby achieve a desired quality of service, said apparatus comprising:

first determining means configured to determine a target equivalent bandwidth required by said traffic stream to meet said desired quality of service;

20 second determining means configured to determine a differential bandwidth dependent upon the present bandwidth and the target equivalent bandwidth;

third determining means configured to determine, based upon said differential bandwidth, a probability distribution function; and

25 constraining means configured to constrain, based upon said probability distribution function, transmission of the packet traffic stream, thereby (i) producing an output packet traffic having a pre-determined entropy bound, (ii) allocating to the input

traffic stream said target equivalent bandwidth and (iii) achieving said desired quality of service.

63. A computer readable memory medium for storing a program for an apparatus configured to adjust a present bandwidth allocated to a packet traffic stream to thereby achieve a desired quality of service, said program comprising:

code for a first determining step for determining a target equivalent bandwidth required by said traffic stream to meet said desired quality of service;

code for a second determining step for determining a differential bandwidth dependent upon the present bandwidth and the target equivalent bandwidth;

code for a third determining step for determining, based upon said differential bandwidth, a probability distribution function; and

code for a constraining step for constraining, based upon said probability distribution function, transmission of the packet traffic stream, thereby (i) producing an output packet traffic having a pre-determined entropy bound, (ii) allocating to the input traffic stream said target equivalent bandwidth and (iii) achieving said desired quality of service.

64. A computer program for an apparatus configured to adjust a present bandwidth allocated to a packet traffic stream to thereby achieve a desired quality of service, said program comprising:

code for a first determining step for determining a target equivalent bandwidth required by said traffic stream to meet said desired quality of service;

code for a second determining step for determining a differential bandwidth dependent upon the present bandwidth and the target equivalent bandwidth;

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code for a third determining step for determining, based upon said differential bandwidth, a probability distribution function; and

code for a constraining step for constraining, based upon said probability distribution function, transmission of the packet traffic stream, thereby (i) producing an
5 output packet traffic having a pre-determined entropy bound, (ii) allocating to the input traffic stream said target equivalent bandwidth and (iii) achieving said desired quality of service.

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